

DEC STD 030-5 MODULE MANUFACTURING STANDARD — MODULE ASSEMBLY AND COMPONENT INSERTION RULES

DOCUMENT IDENTIFIER: A-DS-EL00030-05-0 Rev E, 17-June-1991

ABSTRACT: This section of DEC STD 030 provides the design requirements for all module assemblies.

APPLICABILITY: This standard is mandatory for designs to be compatible with the standard volume manufacturing process. Site Producibility Engineers are available to provide additional information on specific areas not covered in this standard.

STATUS: APPROVED 17-June-1991; use VTX SMC for current status.

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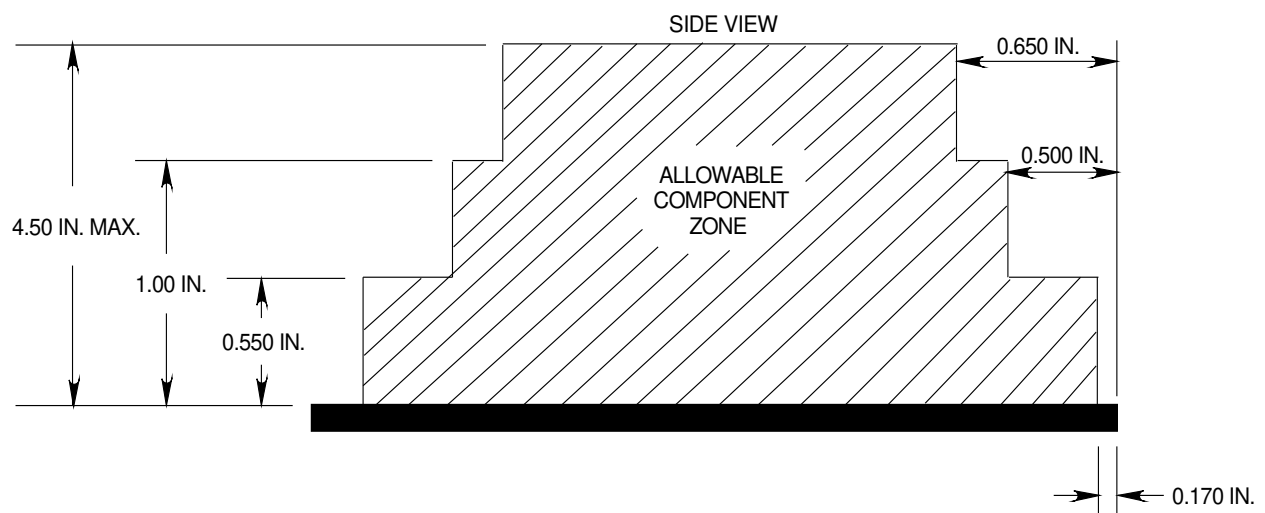
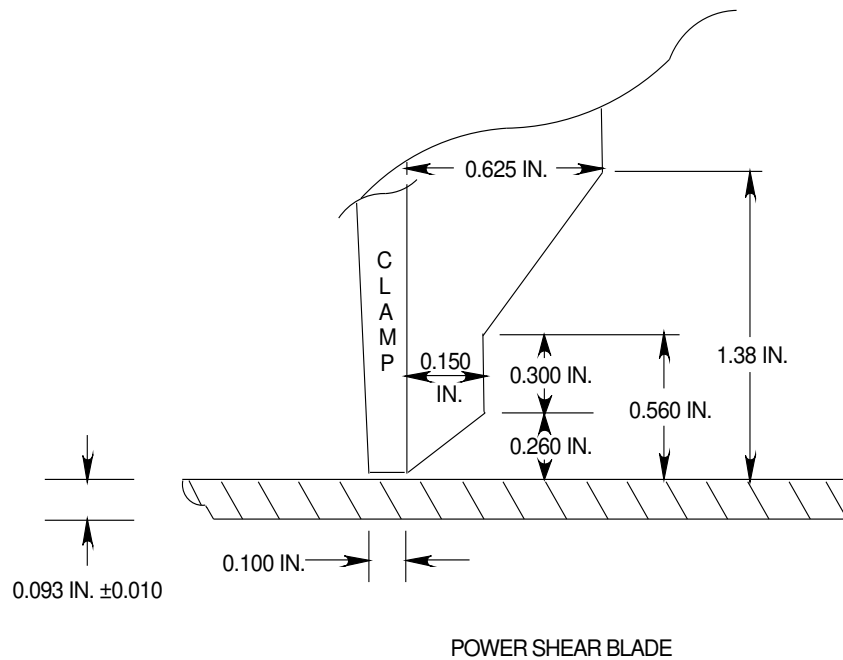
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Exhibit 2: Standard Fingerless Circuit Component Clearance Requirements for Shearing

RULE 5001: CLEARANCE REQUIREMENTS FOR HAND ASSEMBLY

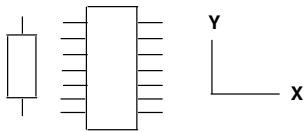
The clearance requirements for hand assembly shall be in accordance with the dimensions shown in Exhibit 3.

Exhibit 3: Minimum Clearance Requirements for Hand Assembly Parts, Adjacent, Similar

Code	Part Type	Clearance X (Notes 1 and 2)	Clearance Y (Notes 1 and 2)
HA	1-pin	B-B 0.050 X	B-B 0.050 Y
HB	2-pin	P-P 0.400 X*	P-P 0.100 Y
HC	2-pin w/polarity	P-P 0.400 X*	P-P 0.100 Y
HD	3-pin	B-B 0.050 X	B-B 0.050 Y
HE	3-pin w/polarity	B-B 0.050 X	B-B 0.050 Y
HF	Dual in-line package (DIP)	P-P 0.100 X	P-P 0.150 Y
HG	Single in-line package (SIP) (Note 3)	P-P 0.100 X	P-P 0.100 Y
HH	Zigzag in-line package (ZIP)	P-P 0.050 X	P-P 0.100 Y
HI	4-pin	B-B 0.100 X	B-B 0.100 Y
HJ	4-pin w/polarity	B-B 0.100 X	B-B 0.100 Y
HK	PGAs—ceramic	P-P 0.200 X	P-P 0.200 Y
HL	PGAs—plastic	P-P 0.200 X	P-P 0.200 Y
HN	Handle/ejector	B-B 0.100 X	B-B 0.100 Y
HR	Heat sink; removable	B-B 0.100 X	B-B 0.100 Y
HS	Heat sink; fixed	B-B 0.200 X	B-B 0.200 Y

Notes:

1. X and Y reference:



2. Definitions:

B-B = body-to-body

P-P = pin-to-pin (mounting hole center)

3. Brickwalling of SIPs is not recommended. Every third 0.100-inch increment must be left blank for repair access.
4. When assembling parts with different part codes and clearance requirements, the larger clearance must be used.
5. Default minimums are the following.

B-B = 0.050 inch

P-P = 0.100 inch

* = 1/2 combined diameters of two adjacent parts (alternate minimum)

RULE 5003: MELF PACKAGES

MELF Packages shall be located on side one only in mixed mount designs.

3 COMPONENT INSERTION RULES

The following component insertion rules are used to obtain the most cost-effective product design. EL-MF228-00, *Component Categories and Codes for Machine and Non-Machine Insertable Components* specifies insertion codes and pin counts by component class.

3.1 MACHINE-INSERTABLE COMPONENTS**RULE 5005: COMPONENT BODY LENGTH AND DIAMETER FOR MACHINE-INSERTABLE COMPONENTS**

The maximum body length for machine-insertable components is 0.650 inch. The body diameter shall be less than or equal to 0.200 inch.

3.1.1 Common-Use Machine-Insertable Component Rules**RULE 5010: SELECT COMMON-USE MACHINE-INSERTABLE AXIAL COMPONENTS**

Select machine-insertable axial components in accordance with Exhibit 4. If the selected component is not listed in Exhibit 4, but still complies with the reference dimensions shown in Exhibit 5, contact Component Engineering for insertion code assignment.

RULE 5020: SELECT AUTOMATIC MACHINE-INSERTABLE IC PACKAGES

Select automatic 0.300-inch, 0.400-inch, and 0.600-inch machine-insertable IC packages based on the insertability designation in the insertion code field of the Component Master Parts File. Refer to EL-MF228-00 for insertability category definitions. Refer to A-PS-1900000-GS-0, *General Specification, Dimensions, and Packaging Requirements for Multi Packages for Dual In-Line Packages*, for machine-insertable IC dimensional requirements.

3.1.2 Second Choice Machine-Insertable Component Rules**RULE 5040: SECOND CHOICE MACHINE-INSERTABLE COMPONENTS**

Use second choice machine-insertable components when necessary, based on the L-series or H-series insertability designation specified in the insertion code field of the Component Master Parts File.

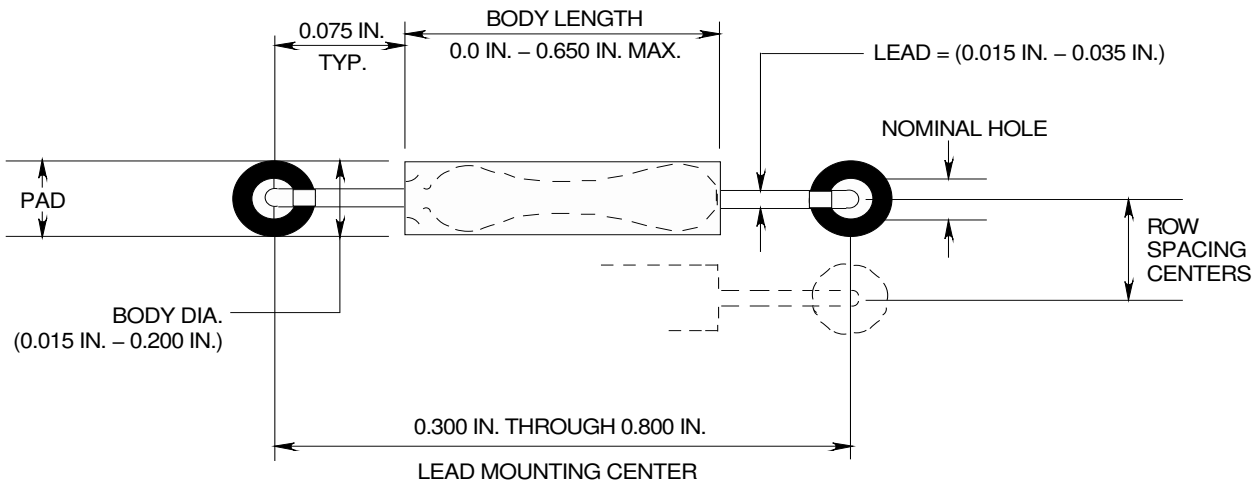
Exhibit 4: Common-Use Machine-Insertable Axial Component Outlines, With Circuit Features

AUTO-INSERTABLE PARTS FOR VCD MACHINE		FINISH CIRCUIT LAYOUT FEATURES (INCH)			
Typical Components	Lead Range (inch)	GS Ref. Code ¹	Lead Mounting Center	Nominal Hole Size ²	Row Spacing Centers
RESISTORS					
1/8W Carbon Film	0.014/0.019	A	0.300	0.038	0.100
1/4W Carbon Film	0.023/0.027	A	0.400	0.038	0.100
1/4W MF RN55	0.023/0.027	A	0.400	0.038	0.100
1/2W MF RN60	0.023/0.027	A	0.600	0.038	0.200
1/2W Carbon Film	0.031/0.035	A	0.600	0.042	0.200
1 W Metal Oxide	0.029/0.034	A	0.800	0.042	0.200
1 W Wire Wound	0.018/0.022	A	0.600	0.038	0.200
1 W Wire Wound	0.018/0.022	A	0.700	0.038	0.200
DIODES					
DO-7 Diode	0.018/0.022	B	0.400	0.038	0.100
DO-35 Diode	0.018/0.022	B	0.400	0.038	0.100
DO-41 Diode	0.030/0.034	B	0.400	0.042	0.200
DO-15 Diode	0.027/0.035	B	0.400	0.042	0.200
JUMPERS					
0-ohm 1/4W Resistor	0.023/0.027	C	0.400	0.038	0.100
Bare Wire Jumper	0.023/0.027	C	0.400	0.038	0.100
CAPACITORS					
A Case Capacitor ³	0.018/0.022	D	0.600	0.038	0.200
CERAX Capacitor 12, 13	0.018/0.022	D	0.400	0.038	0.100
CERAX Capacitor 14	0.023/0.027	D	0.600	0.038	0.200
0.047 Bypass	0.018/0.022	D	0.300	0.038	0.100
0.010 Bypass	0.018/0.022	D	0.300	0.038	0.100
FUSES					
Pico Fuse A	0.030/0.034	E	0.500	0.042	0.100
Pico Fuse B	0.023/0.027	E	0.500	0.038	0.100

Note 1. See Exhibit 32 for an explanation of these reference letters.

Note 2. Nominal hole sizes for standard density designs prior to March 1986 were 0.042 inch; these are not required for new designs.

Note 3. See DEC STD 030-3, Rule 3000.

Exhibit 5: Auto-Inserted Axial Components, Reference Dimensions

Refer to Exhibit 4.

3.2 NONMACHINE-INSERTABLE COMPONENTS**RULE 5050: COMMON USE NONMACHINE-INSERTABLE COMPONENTS**

Select preferred nonmachine-insertable components from Exhibit 6.

RULE 5055: STAKE PINS**a. Part number 90-09149-00 stake pin:**

- Requires a 0.032-inch $\pm$ 0.002-inch hole size (when used for boards of 0.062-inch nominal thickness)
- Requires a minimum side 1 pad size of 0.055 inch (when used for boards of 0.062 /0.093-inch nominal thickness)
- Requires the use of a 0.034 $\pm$ 0.002 inch hole size with boards of 0.093-inch nominal thickness
- Requires a minimum side 2 pad size of 0.070 inch (when used for boards of 0.062 /0.093-inch nominal thickness)
- Shall not be used on boards thicker than 0.093-inch nominal
- Shall not be used on multilayer boards

b. Part number 12-18518-00 compliant pin shall be used where part number 90-09149-00 stake pin cannot be used.

Exhibit 6: Nonmachine-Insertable, Wave-Solderable, Preferred Parts

NON-VCD-INSERTABLE PARTS		FINISH CIRCUIT LAYOUT FEATURES (INCH)	
Preferred Typical Components	Lead Range (inch)	Nominal Hole Size (Note 1)	Row Spacing Centers
0.033 μ F, 0.047 μ F, and 0.015 μ F Mylar Capacitors	See Component Engineering		
TO-5, 18, 92		0.038	
Multiturn POT		0.038	
5, 6, 10 W Resistor		0.055	
DIP Switch	0.014/0.022	0.038	
40-Pin Header	0.025 square	0.042	
40-Pin Header	0.025 Dia.	0.038	
"3M" Flat PC		0.042	
Fast-Ons		0.128	
Split Lugs		0.067	
0.025 square Pins Side 1 (Staking) Side 2 (Note 2)		0.032/0.034 0.032/0.034	
IC Standard Socket		0.038	0.100X
IC "Pin" Socket		0.059	0.100X
Standard Handle		0.133	

Note 1. Nominal Hole sizes for standard density designs prior to March 1986 were 0.042 inch; these are not required for new designs. Use the values shown in Exhibit 4.

Note 2. Etch connection must be made on side 2. On MSL circuits, use a fanout via. Do not make inner layer connections to the staked pin hole, since this may cause an unreliable connection when inserting the staked pin. Refer to Rule 5055.

3.3 AXIAL LEAD MOUNTING CENTERS FOR NONMACHINE-INSERTABLE COMPONENTS

For information on machine-insertable components, see EL-MF228-00 *Component Categories and Codes for Machine and Non-Machine Insertable Components*.

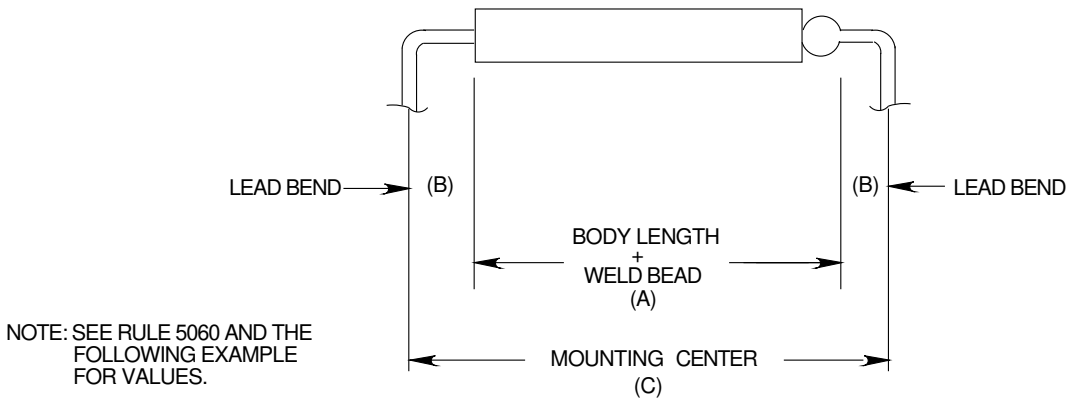
RULE 5060: CALCULATION OF MINIMUM LEAD MOUNTING CENTERS FOR LARGE AXIAL NONMACHINE-INSERTABLE COMPONENTS

Applicability: Axial components with body diameter greater than 0.200 inch.

The lead mounting centers for nonmachine-insertable large axial components are calculated as follows. See Exhibit 7.

Mounting Center C	= A + B, adjusted up to 0.025 inch grid increment
where:	
A	= Maximum body length plus weld bead
B	= Allowance for lead bend
	= 0.150 inch for body length up to 0.625 inch (0.075×2)
	= 0.250 inch for body length greater than 0.625 inch (0.125×2)

Exhibit 7: Mounting Centers Calculation



Example:

Body length	=0.800 inch
Weld bead	=0.085 inch
Lead bend	=0.250 inch
Total	=1.135 inch
Mounting Center	=1.150 inch

4 COMPONENT COMPATIBILITY TO THE ASSEMBLY PROCESS

Compliance with the rules and requirements presented under this heading assures compatibility of components to the assembly process.

4.1 REFLOW/CLEANING PROCESS RULES

This heading contains rules and requirements that assure the selection of components that are compatible to the assembly process.

RULE 5070: COMPATIBILITY WITH DIGITAL'S REFLOW AND CLEANING PROCESSES

Ensure compatibility with Digital's wave solder, SMT reflow, and cleaning processes. Refer to *EL-MF516-00 Surface Mount Technology (SMT) Process Specification*.

RULE 5090: COMPONENT HEIGHT AND LEAD PROTRUSION

Do not use components that exceed 3 inches in height or that protrude below the board surface more than 0.375 inch because they cannot be cleaned or wave soldered within the standard process.

RULE 5095: BATTERIES IN WAVE SOLDER

Batteries shall not be wave soldered unless approved by the responsible component engineer. Explosions can be caused by the high temperatures and by short circuits during wave soldering.

4.2 LEAD LENGTH RULES

RULE 5100: MOUNTING COMPONENTS ON HEAT SINKS

If mounting components on heat sinks, ensure that leads will be long enough to pass through the sink and any spacers, and still be solderable.

RULE 5110: BOARD THICKNESS

Boards thicker than 0.062 inch may require longer lead lengths in order to meet the requirements of EL-SM116-01, *Manufacturing Workmanship Standards and Related Documents: Workmanship Standards - Volume 1*.

4.3 SPACING AND FOOTPRINT REQUIREMENTS

RULE 5130: STANDARD 0.100-INCH GRID LEAD FOOTPRINTS

Use through-hole components with standard 0.100-inch grid lead spacing. See DEC STD 030-4, Rule 4330 for component and via spacing requirements.

RULE 5140: ELECTRICAL AND MECHANICAL SPACING BETWEEN DEVICES

Be aware of electrical and mechanical spacing between devices - especially power devices.

4.4 ASSEMBLY SOLDERMASK REQUIREMENTS

RULE 5142: ASSEMBLY REQUIREMENTS FOR SOLDERMASK

The need for soldermask is determined by the technology of the design and the accessibility of side 1 for finding and repairing solder shorts (for example, in backplanes or in some memory devices). Soldermask shall cover all circuits and shall be used as follows.

- a. On side 2 of high density (12/13 or 15/15) designs.
- b. On side 2, and optionally on side 1, of memories or modems.
- c. On both sides of wave-soldered backplanes with the exception of pads-only etch layers. Refer to DEC STD 030-7, Rule 7030.
- d. On both sides of 8/8 or denser designs.
- e. Do not use soldermask on 20/20 designs other than wave-soldered backplanes.
- f. Holes smaller than 0.020-inch FHS shall be tented. Holes larger than 0.029 FHS cannot be tented reliably.
- g. Tenting must be done on both sides of the board for the same holes to prevent chemical entrapment.

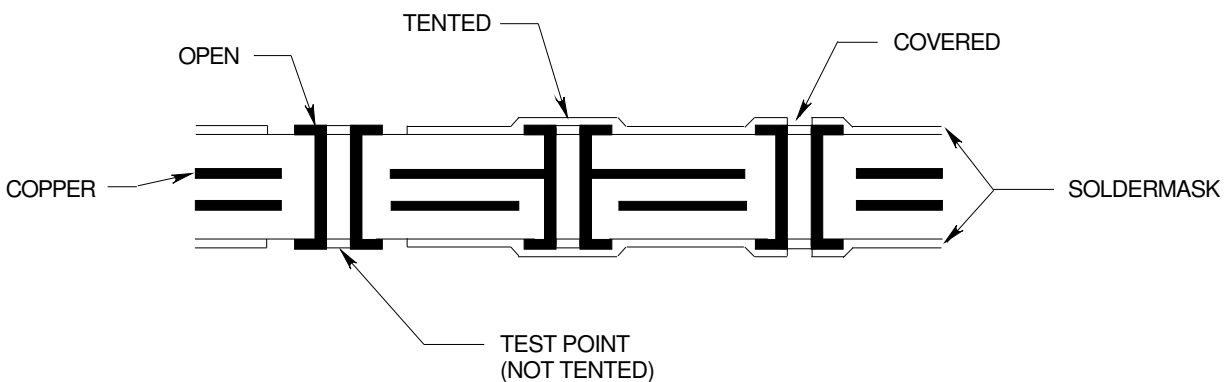
RULE 5144: SOLDERMASK COVERAGE REQUIREMENTS ON PRINTED-WIRING BOARDS

Soldermask must cover the board beneath metal case components and components with less than 0.004-inch clearance.

RULE 5146: TYPE OF SOLDERMASK

- a. Surface mount designs that require via hole tenting shall use dry-film soldermask. Surface mount designs that do not require via hole tenting may use any approved Digital soldermask. For acceptance criteria, see *DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*.
- b. Holes must be tented on both sides of the board to ensure that ATE vacuum test fixtures will work reliably. See Exhibit 8.

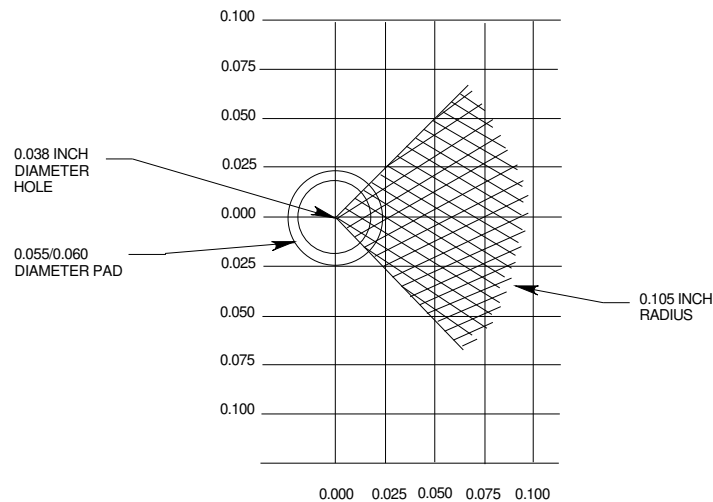
Exhibit 8: Via Hole Tenting and Vias Assigned as Test Points



RULE 5147: SOLDERMASK ON VIA PADS

Via pads shall be free of soldermask with the following exceptions. Some vias must be tented or covered with soldermask to avoid potential shorts or component damage and to accommodate vacuum in-circuit test. This is done per the following algorithms. If a potential via problem exists that is not covered by the algorithms, the via pads should be identified for soldermask rework. See DEC STD 030-4, Rule 4535.

- a. If component-to-via or via-to-via pads are closer than 0.015 inch (edge to edge) the soldermask pad size for one of the via holes must be reduced to equal the size of the hole diameter plus 0.002 inch, or the hole must be tented.
- b. Any via under a two-pin component, within 0.105 inch of either component hole (center-to-center) and within a 90-degree cone between the two component holes, requires a soldermask pad with a diameter equal to the nominal finished hole size plus 0.002 inch, or the hole must be tented. Refer to Exhibit 9.
- c. SMOBC shall not be used on designs with finished hole sizes less than 0.020 inch unless dry-film soldermask is used to tent these holes.

Exhibit 9: Soldermask Coverage of Vias Under Two-Pin Components

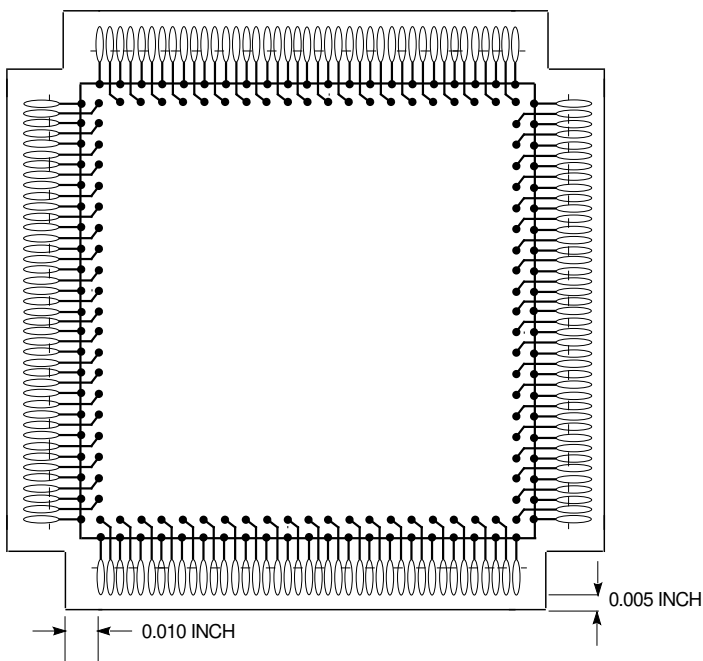
RULE 5149: SOLDERMASK CLEARANCE AROUND FOOTPRINT PADS FOR COMPONENTS WITH 0.025-INCH PITCH OR LESS

Clearance around outer edges of footprint pads for components with 0.025-inch pitch or less is necessary to allow an area for the contact thermode reflow process.

The design data clearance shall be:

1. 0.010 inch out from the long edge of the pad
2. 0.005 inch from the curved (blunt) end.

Refer to Exhibit 10.

Exhibit 10: Soldermask Clearance for Components of 0.025-Inch Pitch or Less

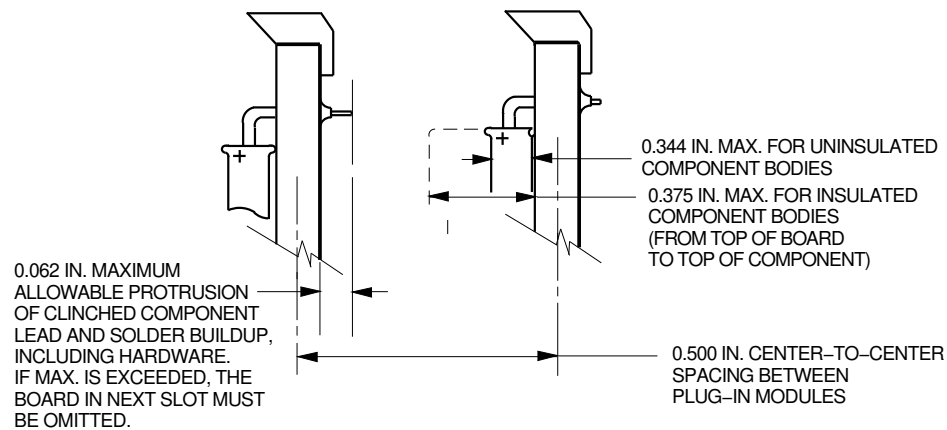
5 PLATED-THROUGH HOLE MODULE ASSEMBLY RULES

The following rules provide the requirements for assembling plated-through hole (PTH) modules.

RULE 5150: CLEARANCE REQUIREMENTS BETWEEN COMPONENTS AND PROTRUSIONS ON ADJACENT MODULES

Component bodies must clear any protrusions of an adjacent module when the modules are plugged into Digital's standard connector blocks. Refer to Exhibit 11.

Exhibit 11: Clearance Required Between Components and Protrusions on Adjacent Modules

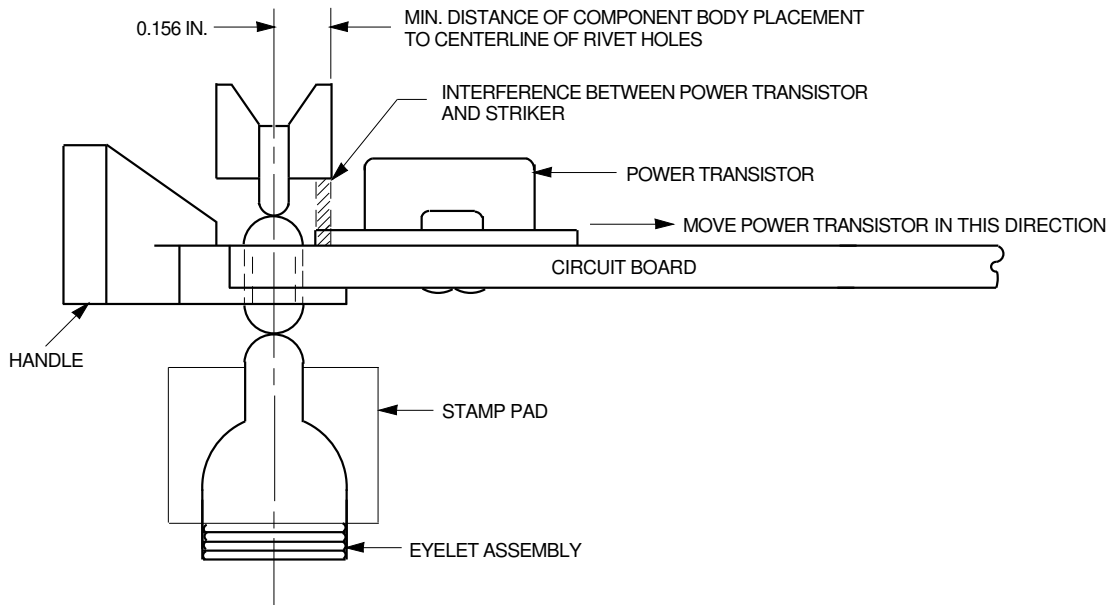


NOTE

Slot spacing must be considered when adding parts to side 2 of a surface mount plug-in module.

RULE 5170: CLEARANCE REQUIREMENTS FOR EYELETTING MACHINE

Exhibit 12 shows the clearance requirements for the eyeletting machine.

Exhibit 12: Clearance Requirements for Eyeletting Machine**RULE 5175: PAD TO MOUNTING HARDWARE, CLIPS, AND HEAT SINKS**

The distance from a pad to mounting hardware, clips, or heat sinks shall be 0.100 inch minimum for high-energy etch and 0.050 inch minimum for low-energy etch. This rule is a Digital product safety requirement. Violations must be reviewed by a product safety engineer. See DEC STD 030-2, Exhibit 1 for UL PWB recognition parameters.

RULE 5180: COMPONENT ELEVATION FROM BOARD FOR THROUGH-HOLE COMPONENTS

Components or parts with 0.5 square inch or more of surface area in contact with the board must be raised off the board surface at least 0.032 inch. Brackets, heat sinks, and TO-3 and TO-66 transistors are typical examples of this requirement. The soldering processes leave flux that cannot be removed from under flush-mounted surfaces. Contamination can also be trapped under such parts and may eventually cause short circuits. Mica or other nonconductive material washers or spacers may be used to comply with this requirement.

RULE 5181: COMPONENT ELEVATION FROM BOARD FOR SURFACE MOUNT COMPONENTS

The minimum clearance between multi-leaded surface mount packages and the PWB shall be 0.006 inch to allow adequate space for cleaning.

RULE 5190: COMPONENT PIN 1 DESIGNATION

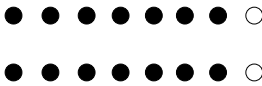
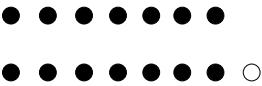
For purposes of automation and machine insertion, all components must have a key pin or lead designated as pin 1, which must be identified in etch or on product documentation. This serves as the main locating feature for all the parts in the automation part libraries, and is the point around which the component will be rotated to achieve the desired orientation. Typically, pin 1 is determined by:

- a. Any pin labeled as *1* on the Purchase Specification or part.
- b. Any pin labeled as *A* on the Purchase Specification or part.
- c. The positive or anode end of any polarized part or cathode of a diode.
- d. Any pin not in the above categories that is desirable to have located *on grid*. It is always necessary to have the pin designated as *1* fall on a grid intersection of whatever grid structure is being used.

RULE 5195: SPACING OF VIAS TO DIPS AND SIPS

Do not place vias 0.100 inch from the end of SIPs or 0.100 inch from both end-leads of DIPs. This will prevent misplacement of DIPs and SIPs. See Exhibit 13.

Exhibit 13: Via-to-Component Lead Spacing

UNACCEPTABLE	ACCEPTABLE
 BOTH VIAS AT END OF DIP	 ONE VIA AT END OF DIP

RULE 5200: CONDUCTOR ROUTING UNDER PLASTIC HANDLES

Etched conductors may be routed under plastic handles; multiwire conductors may not. A minimum of 0.030-inch spacing between etched conductors is required, because the pressure of the eyeletting machine when fastening the handle eyelets can cause the solder-covered conductor to compress in thickness and, therefore, expand in width. See Exhibit 12, shown previously for eyeletting machine clearance requirements.

NOTE

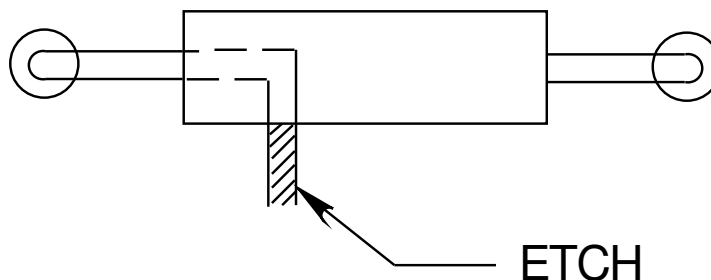
This rule is applicable only to tin-lead fused boards.

RULE 5202: VIAS UNDER COMPONENTS

Do not put vias directly under metal or polystyrene components such as tantalum or aluminum electrolytic capacitors or crystals. This can cause melting of component insulation. For round axial components, vias may be offset by 0.100 inch from the centerline.

RULE 5204: ROUTING OF ETCH LINES UNDER SIDE 1 COMPONENTS

On nonsoldermasked boards, do not route a trace under an axial component connected to that component lead on side 1. Solder can wick-up the lead and run out under the component. See Exhibit 14.

Exhibit 14: Routing of Etch Lines Under Side 1 Components**RULE 5210: USE OF INSULATION FOR METAL PARTS**

Do not rely on the insulating qualities of finishing processes to act as an insulator of metal parts. For example, soldermask material or black anodize on heat sinks are nonconductive; yet they can be scratched easily, exposing the bare metal. Conductors may be routed under metal parts only when insulating material, such as mica or nylon washers, is used between them.

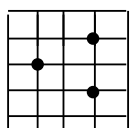
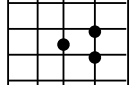
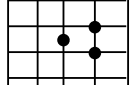
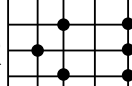
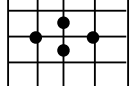
RULE 5215: LEAD SPACING FOR TRANSISTORS

Transistor leads should be laid out so that lead spacing is greater than the distance of the leads exiting the component package. Spacing the leads as shown in Exhibit 15 will keep the transistor body off the board surface without the need for extra parts, thus preventing entrapment of contaminants under the component. Refer to Exhibit 15 for recommended transistor lead spacing on 0.050- and 0.100-inch grids.

NOTE

Most metal-case transistors have tabs that require extra clearance. Ensure sufficient clearance for these transistors.

Exhibit 15: Transistor Grid Layout Chart

TRANSISTOR PACKAGE	PACKAGE LEAD PATTERN	LEAD PATTERNS ON GRID
THREE LEADS: TO-5 TO-39		0.200- 0.200 
TO-18		0.100- 0.100 
TO-92 TO-226		0.100- 0.100 
TO-220 TO-126		EITHER 
FOUR LEADS: TO-72		0.100- 0.200 

ALL DIMENSIONS IN INCHES

REFERENCE: A-PS-1500003-GS

RULE 5220: ORDER OF CHOICE FOR BYPASS CAPACITORS

Refer to Exhibit 16 to select bypass capacitors.

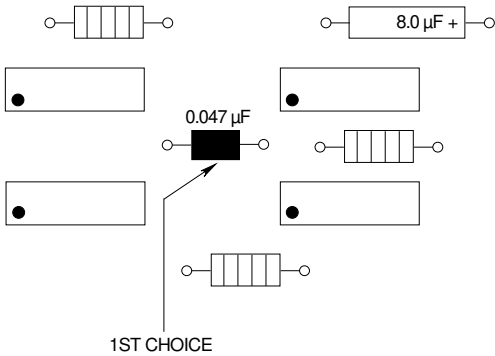
Exhibit 16: Bypass Capacitor Selection

Choice	Value	Digital Part Number	Mounting Centers	Quantity Per IC	Insertion Methods
1st	0.047 μ F	10-12784-00	0.300 inch	1 per 4 ICs	Same as axials
2nd	0.01 μ F	10-01610-00	0.300 inch	1 per IC	Same as axials

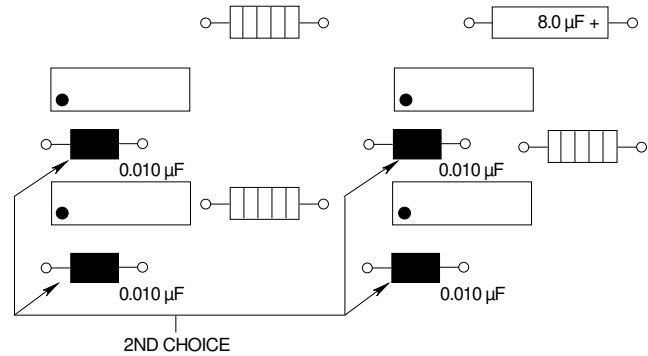
RULE 5230: CAPACITOR LAYOUT RULES

First and second choice capacitor layout rules are shown in Exhibit 17. If a memory device is being used in a design, the engineer should consult Memory Engineering.

Exhibit 17: Capacitor Layout Rules



0.047 μ F ON 0.300 IN. CENTERS AND ALIGNED WITH OTHER AXIAL PARTS. LOCATE NEAR CENTER OF A CLUSTER OF 4 ICs.



0.010 μ F ON 0.300 IN. CENTERS ALIGNED WITH OTHER AXIAL PARTS. LOCATED NEAR VCC ON EACH IC.

RULE 5240: LOW-PASS FILTER CAPACITORS

Unless otherwise specified by the responsible engineer, an aluminum electrolytic capacitor with a value greater than 6 μ F selected from A-PS-1000100-GS-0 *must* be provided for each +5 V input connector pin. Typically a 10 μ F, 35 V capacitor, Digital part number 10-17472-00, laid out on 0.800-inch center will satisfy this requirement.

CAUTION

Do not use tantalum capacitors in applications where fault currents exceed 300 mA.
See DEC STD 030-3, Rule 3000.

RULE 5250: STANDARD REFERENCE DESIGNATORS

Standard reference designators to components shall be assigned per *DEC STD 056-3 Symbolology - Discrete Electronic and Electromechanical Component Symbols*.

6 SMT MODULE ASSEMBLY RULES

The rules in this heading are designed to ensure compatibility with the SMT module assembly process. See EL-MF417-02, *Surface Mount Technology Reference Manual - Volume 2*, for additional information.

RULE 5600: SURFACE MOUNT COMPONENT-TO-COMPONENT PLACEMENT REQUIREMENTS

Surface mount component-to-component placement rules are detailed in Exhibit 18, Exhibit 19, and Exhibit 20.

Exhibit 18: Clearance Requirements Package Style Comparison

Package Style No.	Package Style No.			
	#1	#2	#3	#4
#1	0.024 inch I-R 0.068 inch wave P-P (Note 2)			
#2	0.085 inch B-B	0.085 inch B-B		
#3	0.085 inch B-B	0.085 inch B-B	0.085 inch B-B	
#3A	0.085 inch B-B	0.150 inch P-P	0.150 inch P-P	
#4	0.150 inch P-P (per Rule 5680)	0.150 inch P-P (per Rule 5680)	0.300 inch P-P	0.300 inch P-P

Notes:**1. Definitions:**

P-P = pad-to-pad

B-B = body-to-body

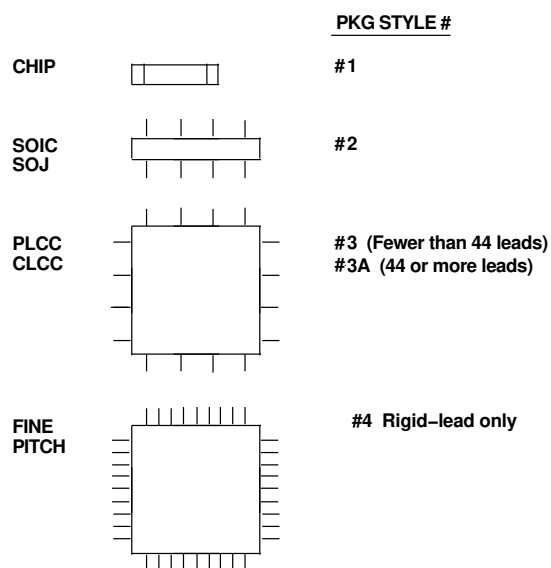
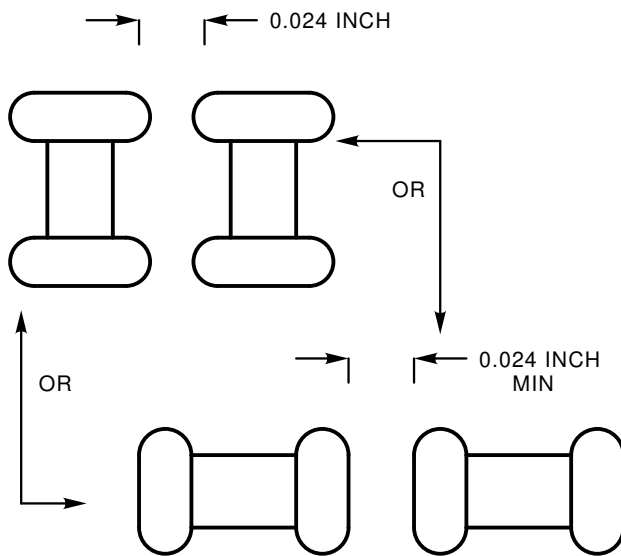
2. B-B if package overshadows footprint**3. Package style diagrams:**

Exhibit 19: Typical Spacing for Two-Leaded (Side 1 and Side 2) Surface Mount Components

SURFACE MOUNT TECHNOLOGY

For two-leaded surface mount components on side 1 or side 2, the orientation can be either way, provided there are no wave-soldered parts.

VIEWED FROM SIDE 1 OR SIDE 2



ONE ORIENTATION PER SIDE
PREFERRED

MIXED TECHNOLOGY

For two-leaded surface mount components on side 2, the orientation must be as shown if there are wave-soldered parts.

VIEWED FROM SIDE 2

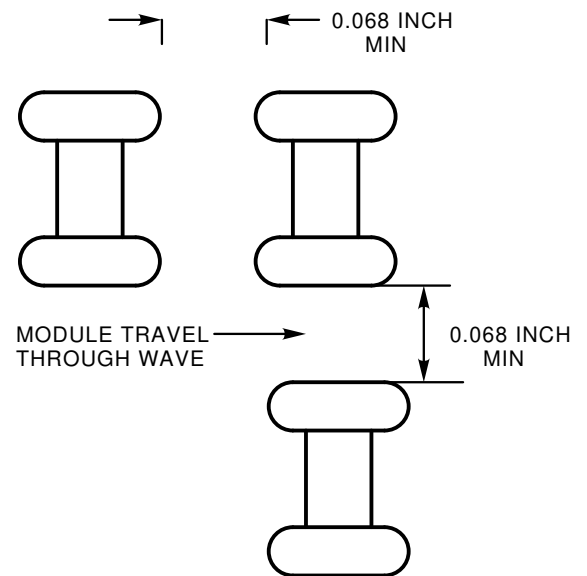
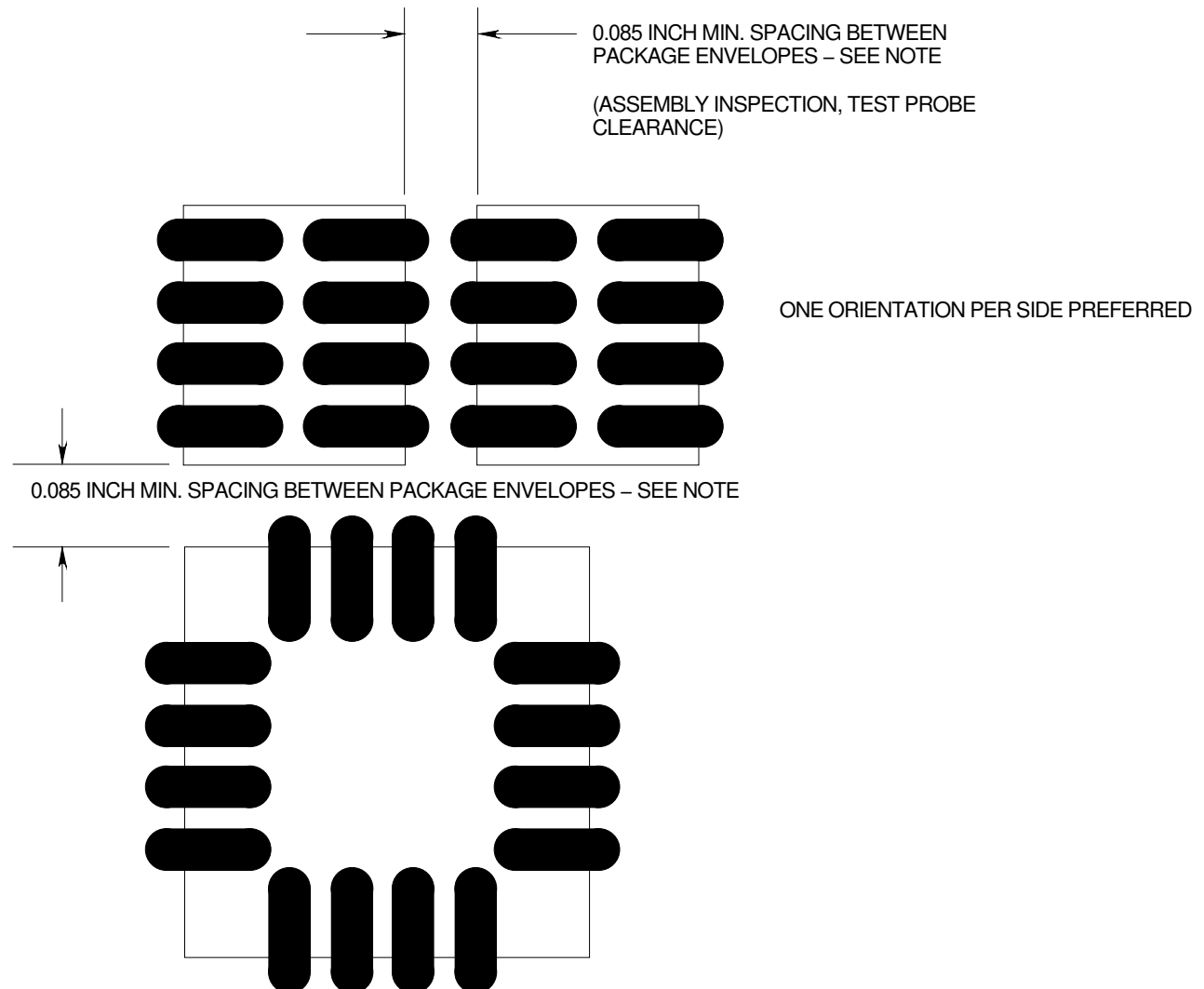


Exhibit 20: Lead-to-Lead Clearances for Surface Mount Components**NOTE**

The package envelope includes the outline of the entire component body and the lead extreme with the exception of the horizontal portion of the gull-wing lead.

See DEC STD 030-6, Rule 6290 and DEC STD 030-6, Rule 6300 for test probe clearance requirements.

RULE 5610: MINIMUM PAD-TO-PAD CLEARANCE REQUIREMENTS

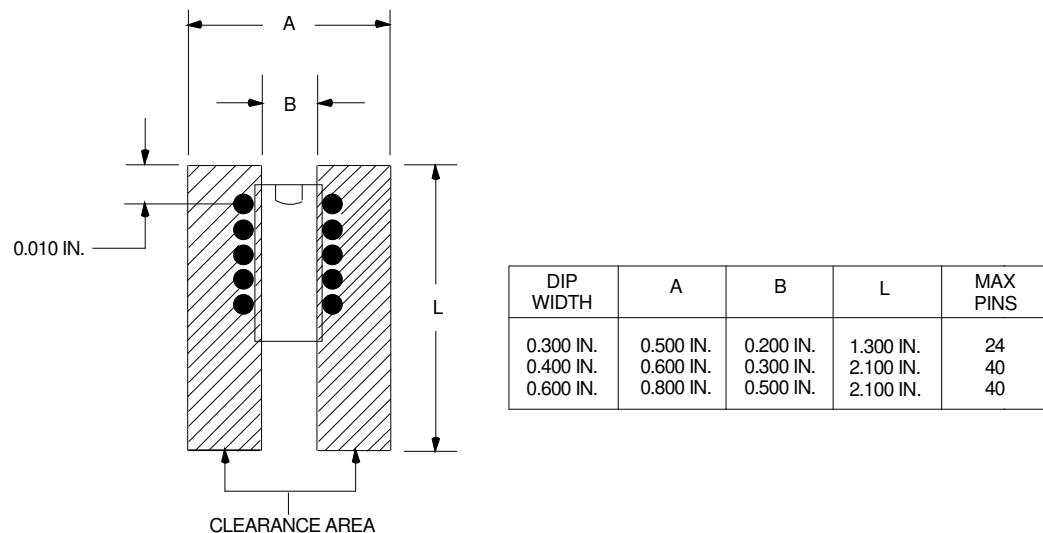
Pads with less than 0.015-inch clearance shall not be soldermasked or exposed to the solderwave.

RULE 5620: EQUALIZING DISTRIBUTION OF SMT COMPONENTS

To equalize thermal gradients across the board during surface mount reflow, components shall be equally dispersed over an entire area of the board. Large surface mount components shall not be clustered in any one area of the board.

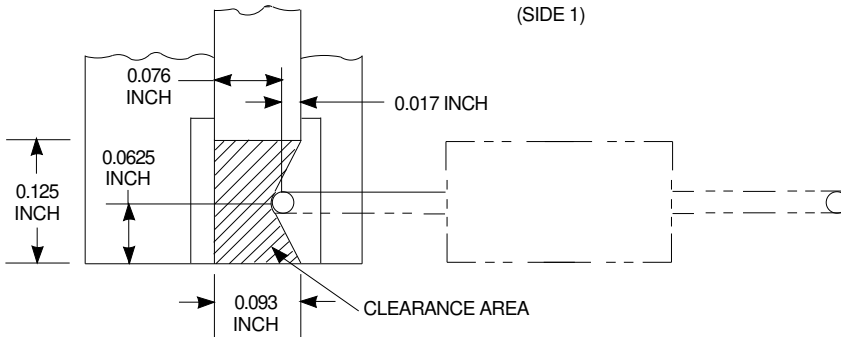
RULE 5630: DUAL-IN-LINE (DIP) TO SURFACE MOUNT DEVICE CLEARANCE REQUIREMENTS

Surface mount devices shall not be placed in the shaded areas indicated in Exhibit 21 to provide clearance for the DIP insertion tool. This clearance is required on side 1 only.

Exhibit 21: DIP-to-Surface Mount Device Clearances

RULE 5640: CLEARANCE REQUIREMENTS FOR VCD INSERTION TOOLING

Surface mount devices shall not be placed in the void areas indicated in Exhibit 22 to provide clearance for the axial insertion tool. This clearance is required on side 1 only.

Exhibit 22: Axial Component Head and Former Dimensions**RULE 5650: TOOLING RESTRICTION, INSEPARABLE HEAT SINKS**

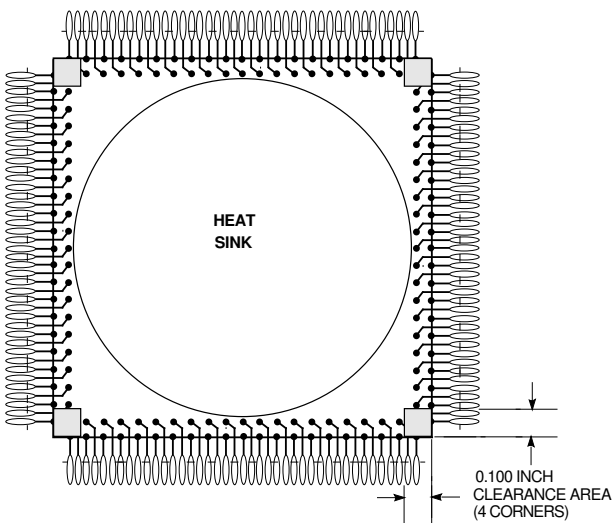
When selecting or designing a heat sink for permanent attachment to the top surface of a device, a 0.100-inch $\times$ 0.100-inch area on each corner of that device must be kept clear for the chuck mechanism of pick-and-place equipment (Quad). Refer to Exhibit 23.

RULE 5651: HEAT SINK SIZE

Inseparable heat sinks shall not exceed the mated device body outlines.

RULE 5652: SEPARABLE HEAT SINKS

Applications using separable heat sinks are not restricted by Rule 5650 and Rule 5651.

Exhibit 23: Tooling Restriction, Device Top Surface

RULE 5660: MAXIMUM HEIGHT REQUIREMENTS FOR PLUG-IN MODULES

Maximum heights listed in DEC STD 030-1, Exhibit 23 are for modules that plug into backplanes with slot spacings of 0.500 inch for 0.062-inch thick modules, or with 0.750-inch slot spacings for 0.093-inch thick modules.

RULE 5670: MAXIMUM HEIGHT REQUIREMENTS FOR THE VOLUME MANUFACTURING PROCESS

The total board height (board profile) including side 1 and side 2 components, heat sinks, and the board itself, shall not exceed 0.875 inch for Centech CVP-1C Infrared equipment.

RULE 5680: COMPONENT CLEARANCE REQUIREMENTS FOR ASSEMBLY FIXTURING (0.025-INCH PITCH COMPONENTS)

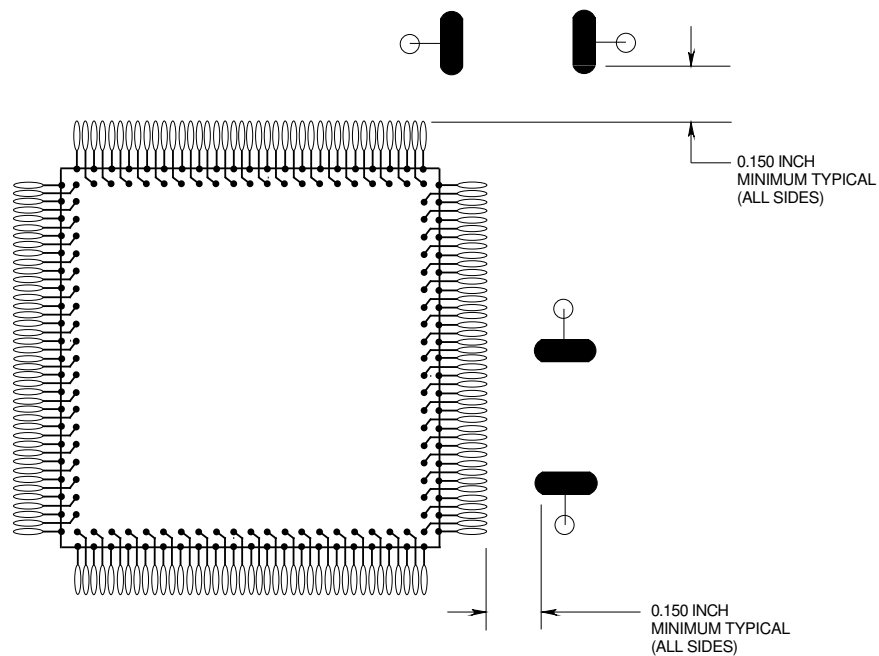
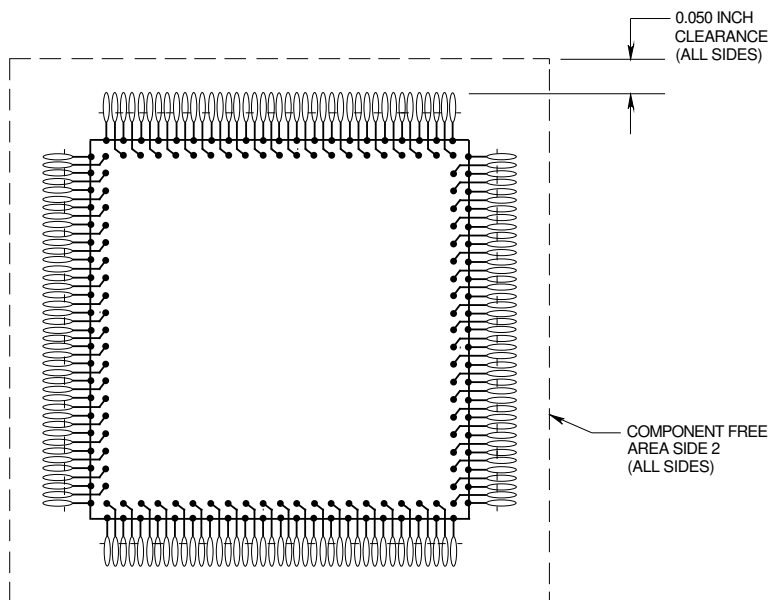
For 0.025-inch pitch components, minimum spacing from solder pad to solder pad is 0.150 inch on the side the component is mounted. See Exhibit 24.

On the opposite side of the board, there must be 0.050-inch area left free of components all around the solder pad for the fine pitch device. See Exhibit 25.

RULE 5690: MOUNTING BACK-TO-BACK FINE PITCH COMPONENTS

The following requirements apply when mounting fine pitch components back-to-back on both sides of a module. Refer to Rule 5680 for component clearance requirements.

- a. Both components must be centered on the same axis.
- b. Mount the smaller size component on side 1 (assuming it will be assembled first) and the larger size on side 2 (assuming it will be assembled after side 1).

Exhibit 24: Clearance Requirements for 0.025-Inch Pitch Components - Side 1**Exhibit 25: Clearance Requirements for 0.025-Inch Pitch Components - Side 2**

RULE 5700: SURFACE MOUNT DEVICE PAD RESTRICTIONS

Do not use vias within the surface mount device pad.

RULE 5710: SMD VIA AND ETCH RESTRICTIONS

Do not run conductors or place vias between the footprint pads of 0805, 1206, or 1210 packages.

RULE 5730: EXTERNAL LAYER DISPERSION ETCH WIDTH

Use equal width dispersion from each pad on the same component.

RULE 5740: EXTERNAL LAYER DISPERSION ETCH LENGTH

Minimum external layer dispersion etch length is 0.025 inch. Refer to DEC STD 030-4, Rule 4321.

RULE 5800: GENERAL FIDUCIAL REQUIREMENTS

Fiducials, or visual reference targets, are to be used on designs employing surface mount devices and shall be configured using the following guidelines. Refer to Exhibit 26.

Shape: Round

Size: 0.040-inch diameter

Coverage: Preferred free of soldermask for a 0.080-inch diameter

Clearance (circuit-level only):

1. Minimum distance of fiducial edge from the edge of the PWB must be 0.200 inch
2. Minimum distance of fiducial center from any other board feature must be 0.100 inch

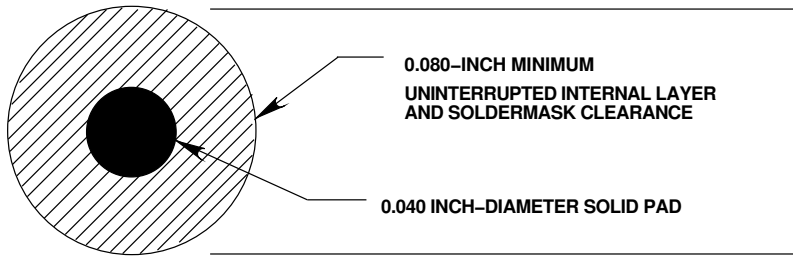
Background: Shall be **dark** and can be accomplished by the following.

- a. Maintaining an uninterrupted solid copper area of 0.080-inch in diameter on the internal layer directly beneath the fiducial
- b. Maintaining an area of 0.080 inch in diameter free of routed lines beneath the fiducial for a depth of 0.016 inch into the PWB layers

NOTE

The use of a dark opaque PWB material may satisfy the background requirement without implementing a or b. However, satisfying this requirement should not be the sole reason for that material selection.

Exhibit 26: Fiducial Configuration



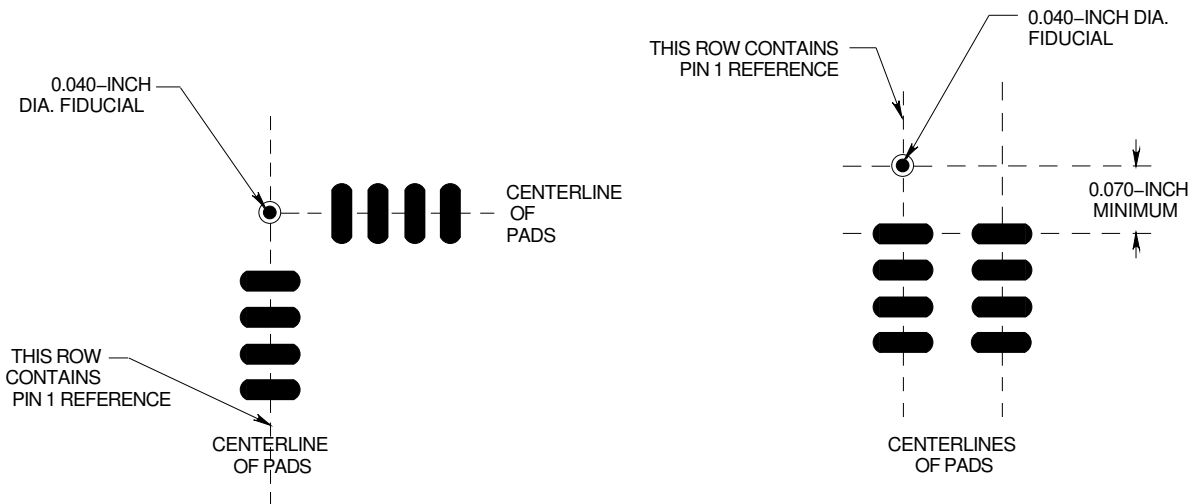
RULE 5810: COMPONENT-LEVEL FIDUCIALS

Fiducials are required for all 0.050-inch pitch surface mount components with lead counts greater than or equal to 44 pins and for all components with lead pitch less than 0.050 inch.

Two fiducials shall be placed within the surface mount component footprint pattern diagonally opposite each other in the upper left and lower right of the part with pin 1 being on the left. See Exhibit 27.

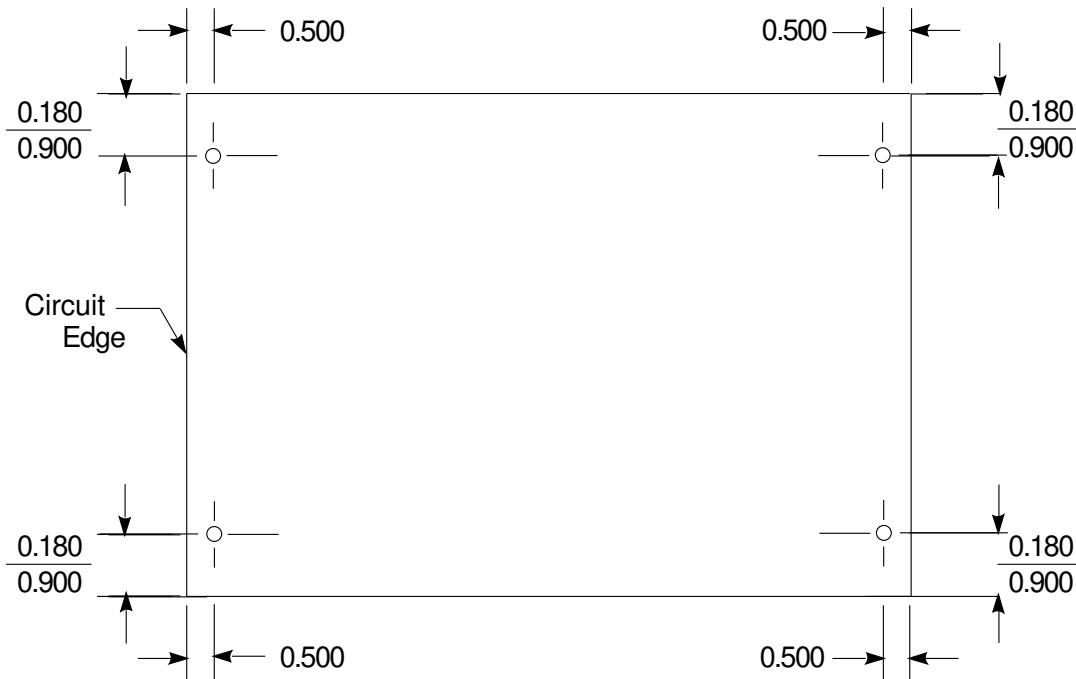
Positional accuracy of fiducials to any footprint pad shall be equal to that of the pads.

Exhibit 27: Component-Level Fiducials



RULE 5820: CIRCUIT-LEVEL FIDUCIALS

- a. Fiducials shall be placed in all four corners of each side of a PWB (side 1, side 2, or both) that contains surface mount components.
- b. All dimensions are measured from the center of fiducials.
- c. See Exhibit 28 for recommended locations.

Exhibit 28: Fiducial Placement (Side 1/Side 2)

7 NUMBERING SEQUENCE GUIDELINES

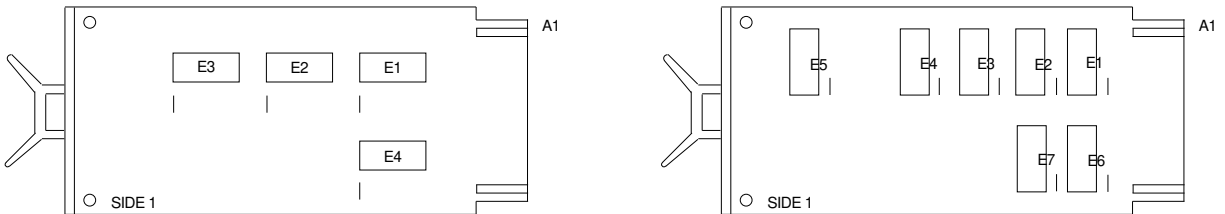
The guidelines within this heading cover numbering sequences for ICs on single-sided and double-sided boards and for discrete components. Guidelines for locating spare ICs are also presented.

7.1 IC NUMBERING SEQUENCE — SINGLE-SIDED BOARDS

Guidelines for standard numbering sequence and standard and nonstandard placement of reference designations follow.

- a. The standard numbering sequence is used to locate a specific IC since component reference designations are not marked on a board as standard procedure. Start in the corner nearest H Master 0. Exhibit 29 shows the standard method.
- b. Standard placement — It is standard practice to have the reference designation of the last IC of each row etched on side 1 (near the handle) of quad and hex boards. This aids identification of location when many ICs are on the board.
- c. Nonstandard placement — If ICs are not located in obvious row patterns or are not in sequential order, the reference designation(s) must be visibly etched on side 1. If there is a lack of space, only the number need appear (10 instead of E10). The intent is to make it as easy as possible to locate any given IC when necessary.

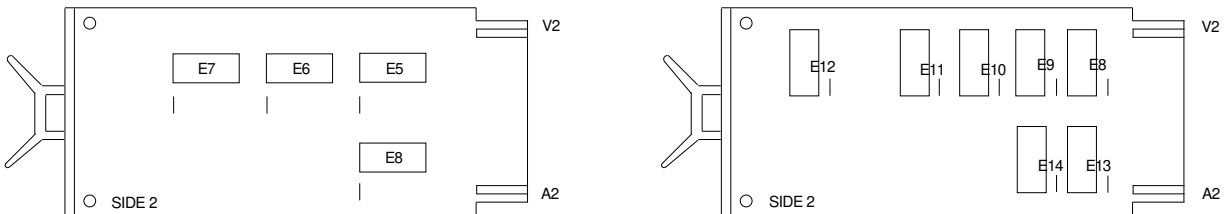
Exhibit 29: IC Numbering Sequence - Single-Sided Boards



7.2 IC NUMBERING SEQUENCE — DOUBLE-SIDED BOARDS

All *E* designated components on side 2 of the circuit shall be numbered in a consecutive sequence, continued from side 1, as shown in Exhibit 30.

Exhibit 30: IC Numbering Sequence — Double-Sided Boards



7.3 DISCRETE COMPONENT NUMBERING SEQUENCE

Unlike ICs, the physical location of a discrete component on the board has no relationship to its reference designator.

7.4 GUIDELINES FOR SPARE IC LOCATIONS

Whenever possible, provide spare 16-pin DIP IC locations. If space permits, terminate the IC pins at via pads as shown in Exhibit 31. If possible, provide for a decoupling capacitor to be connected to power and ground. Spare IC locations shall be assigned a reference designation as though an IC were actually installed.

The IC location should not be prepowered unless specified by the engineer. The IC and capacitor should be oriented in the same direction as other ICs and axials on the board.

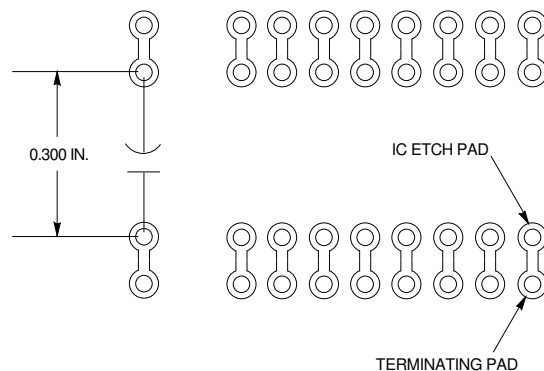
Spare IC locations should be listed under “Notes” on the UA drawing. Decoupling capacitor locations for these spare IC locations should also be listed, but only if the capacitors are not actually installed. For example:

Spare IC locations: E154, E147, E91

Spare capacitor locations: C167, C106, C165

If the capacitors are installed, do not list them on the UA drawing.

Exhibit 31: Spare IC Locations



8 MODULE IDENTIFICATION

This heading presents Manufacturing and Design Engineering responsibilities for identifying modules. Marking requirements based on product need and the order of precedence in marking handles are also included.

RULE 5910: MANUFACTURING RESPONSIBILITY FOR IDENTIFYING MODULES

To facilitate the identification of assembled modules, either before or after installation in a system, there is a required minimum of information descriptive of its 54-level identity that must be present on a module. The following is the required minimum.

Descriptor	Example
Module Number	M7241, L4001, 54-12345
Module Variation	-YA, -AF, -04
Revision	A04
Mfg Date Code	917 (year week week)

NOTE

The preceding requirement is dependent on availability of handle surfaces or module surface area to affix minimum markings by using bar code labels, impression stamps, or ink.

Manufacturing is responsible for affixing these identification elements using one of the following:

- a. Bar coded labels
- b. Printed labels
- c. Imprint (either impression stamp or ink)

Manufacturing is responsible for affixing these identification elements to whichever of the following areas has been provided by the design.

- a. Handle ears or top face for customer/service access
- b. Handle side surface (module side 2)
- c. Module side 2
- d. Module side 1

NOTE

It is the intent of this rule to make it mandatory that, at a minimum, when the handle top face allows, the module part number and module variation must be applied to that surface.

RULE 5920: DESIGN ENGINEERING RESPONSIBILITY FOR IDENTIFYING MODULES

It is the responsibility of Design Engineering to include in the design the appropriate measures that will provide module manufacturing adequate opportunity to affix the required elements of identification at the time of assembly. The following lists those measures in descending order of preference.

1. A handle, of sufficient size to allow having an identification label affixed to its top face, thereby facilitating customer service identification while the module remains at a plugged in and powered up state.
2. Clear module surface area if a handle is not intended to be used. Refer to DEC STD 030-1, Rule 1200.

RULE 5930: HIGHER LEVEL PRODUCT OPTION MARKINGS

Additional information may be required on a product driven need basis. That information is but need not be limited to the following.

Descriptor	Example
Product Option Number	MS250
Option Variation	-BA
Serial Number	ZGO12345678

If there are to be product mandated identification requirements over and above those listed in Rule 5910, those requirements and methods shall be detailed in product documentation, for example, Module UA drawing.

RULE 5940: PRECEDENCE OF IDENTIFICATION MARKINGS USED

1. If a module has a handle with a top face wide enough to accept a continuous bar code label with module part number, module revision, and module serial number or date code, the use of such a label may take precedence for meeting module identification marking requirements.
2. If a module does not have a handle with a top face wide enough for a continuous bar code label, but has a handle with ears large enough to contain the basic module part number, the basic part number should be imprinted or stamped onto an ear of the handle. For example, M7551, G451, L4001. The remaining identification markings, preferably on bar coded labels should be applied to either the side 2 handle area or side 2 module surface, as space requirements dictate.

RULE 5950: PLASTIC FLIP-CHIP HANDLES

Plastic flip-chip handles (9008337-xx) are intended to have the module number hot stamped on the ear. Refer to *A-SP-ELMF308-00, Digital Module Process Handbook*. All other identification requirements can be met by affixing the markings to the side 2 surface of the handle.

9 GENERAL SPECIFICATION REFERENCE GUIDE

The specifications listed in Exhibit 32 are referenced using a GS Reference Code from Exhibit 4. This Exhibit can be used as a guideline to determine which specifications are applicable to a particular requirement.

Exhibit 32: General Specification Reference Guide

GS Ref *	Document Identifier	Related Part Type	Comments/Use
A	A-PS-1300000-GS-0	Resistor	Carbon composition **
	A-PS-1300001-GS-0	Resistor	Metal film
	A-PS-1300004-GS-0	Resistor	Wire wound
	A-PS-1300009-GS-0	Resistor	Carbon film
	A-PS-1300010-GS-0	Resistor	Metal oxide
	A-PS-1300012-GS-0	Resistor	Metal film, fusible
	A-PS-1314350-0-0	Resistor	2W wire-wound fusible
	A-PS-1315518-0-0	Resistor	1W wire-wound fusible
—	A-PS-1300005-GS-0	Resistor	Networks, thick film
	A-PS-1300007-GS-0	Resistor	Precision, stable
	A-PS-1300011-GS-0	Varistor	Voltage suppression
	A-PS-1300013-GS-0	Resistor	Chip, surface mount
	A-PS-1300015-GS-0	Resistor	Vertical mount, power
	A-PS-1309143-0-0	Resistor	Variable, trimmer
	A-PS-1309150-0-0	Resistor	Variable, trimmer
	A-PS-1314270-0-0	Thermistor	In-rush current suppression
B	A-PS-1100004-GS-0	Diode	DO-7, DO-35, DO-41
	A-PS-1118820-0-0	Diode	DO-15
C	A-PS-9009185-0-0	Jumper	Insulated wire
	A-PS-9010430-0-0	Jumper	Bare wire
D	A-PS-1000001-GS-0	Capacitor	Polyester film
	A-PS-1000002-GS-0	Capacitor	Tantalum, axial
	A-PS-1000100-GS-0	Capacitor	Aluminum, axial
	A-PS-1000103-GS-0	Capacitor	Ceramic, axial
	A-PS-1001610-0-0	Capacitor	0.01 uFD ceramic bypass
—	A-PS-1000003-GS-0	Capacitor	Mica
	A-PS-1000101-GS-0	Capacitor	Aluminum, radial, PC mount
	A-PS-1000104-GS-0	Capacitor	Ceramic, radial
	A-PS-1000105-GS-0	Capacitor	Ceramic, radial, surface mount
	A-PS-1000106-GS-0	Capacitor	Tantalum, chip, surface mount
E	A-PS-1210929-0-0	Fuse	Pico
—	A-PS-1200018-GS-0		Press-pin components
	A-PS-1900000-GS-0	DIP	Standard outlines
	E-MD-7606043-0-0	Connector	Standard board edge, plug-in

* See Exhibit 4.

** See DEC STD 030-3, Rule 3040.

REFERENCED DOCUMENTS

EL-Class Digital Documents

EL-Class Number	Document Title
EL-00030-01	<i>DEC STD 030-1 Module Manufacturing Standard - General Producibility Requirements</i>
EL-00030-02	<i>DEC STD 030-2 Module Manufacturing Standard - Product Safety Requirements</i>
EL-00030-03	<i>DEC STD 030-3 Module Manufacturing Standard - Component Selection Rules</i>
EL-00030-04	<i>DEC STD 030-4 Module Manufacturing Standard - Printed-Wiring Board Design Requirements</i>
EL-00056-03	<i>DEC STD 056-3 Symbolology - Discrete Electronic and Electromechanical Component Symbols</i>
EL-00176-00	<i>DEC STD 176-0 Printed-Wiring Board Acceptance Criteria</i>
EL-MF228-00	<i>Component Categories and Codes for Machine and Non-Machine Insertable Components</i>
EL-MF308-00	<i>Digital Module Process Handbook—Introduction and General Information</i>
EL-MF417-02	<i>Surface Mount Technology Reference Manual—Volume 2</i>
EL-MF516-00	<i>Surface Mount Technology (SMT) Process Specification</i>
EL-SM116-01	<i>Manufacturing Workmanship Standards and Related Documents: Workmanship Standards—Volume 1</i>

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

Other Documents

Document Number	Document Title
A-PS-1000100-GS-0	<i>Capacitors, Axial Leaded, Aluminum Electrolytic, General Specification for</i>
A-PS-1900000-GS-0	<i>General Specification, Dimensions, and Packaging Requirements for Multi Packages for Dual In-line Packages</i>
A-PS-150000-GS	<i>General Specification for TO Cases</i>

Purchase specifications, including those listed in Exhibit 32, are available from any Microfilm Reference Library (35 mm aperture card “tub”) or the SPOC system.

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